



01/27/99

01/27/99

PTO
U.S.
09/23/99
01/27/99**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.

35.C13272

First Named Inventor or Application Identifier

FUMIO HATA

Express Mail Label No.

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO:Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231☐

Fee Transmittal Form

(Submit an original, and a duplicate for fee processing)

2. ☒

Specification

Total Pages

16

3. ☒

Drawing(s) (35 USC 113)

Total Sheets

3

4. ☒

Oath or Declaration

Total Pages

1

a. ☐

Newly executed (original or copy)

b. ☒

Unexecuted for information purposes

c. ☐Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
[Note Box 5 below]i. ☐**DELETION OF INVENTOR(S)**Signed Statement attached deleting
inventor(s) named in the prior application,
see 37 CFR 1.63(d)(2) and 1.33(b).5. ☐

Incorporation By Reference (useable if Box 4c is checked)

The entire disclosure of the prior application, from which a copy
of the oath or declaration is supplied under Box 4c, is considered
as being part of the disclosure of the accompanying application
and is hereby incorporated by reference therein.6. ☐

Microfiche Computer Program (Appendix)

7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)a. ☐

Computer Readable Copy

b. ☐

Paper Copy (identical to computer copy)

c. ☐

Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS8. ☐

Assignment Papers (cover sheet & document(s))

9. ☐37 CFR 3.73(b) Statement
(when there is an assignee)☐

Power of Attorney

10. ☐

English Translation Document (if applicable)

11. ☐Information Disclosure
Statement (IDS)/PTO-1449☐Copies of IDS
Citations12. ☐

Preliminary Amendment

13. ☒Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)14. ☐

Small Entity

☐Statement filed in prior
application

Statement(s)

Status still proper and desired

15. ☐Certified Copy of Priority Document(s)
(if foreign priority is claimed)16. ☐

Other: _____

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐

Continuation

☐

Divisional

☐

Continuation-in-part (CIP)

of prior application No. ____/____

18. CORRESPONDENCE ADDRESS☒

Customer Number or Bar Code Label

05514

(Insert Customer No. or Attach bar code label here)

or ☐

Correspondence address below

NAME

Address

City

State

Zip Code

Country

Telephone

Fax



CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	16-20 =	0	X \$ 18.00 =	\$0
	INDEPENDENT CLAIMS (37 cfr 1.16(b))	2-3 =	0	X \$ 78.00 =	\$0
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			\$260.00 =	\$0
				BASIC FEE (37 CFR 1.16(a))	\$760.00
			Total of above Calculations =		\$760.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				0
	TOTAL =				\$760.00

19. Small entity status


- a. ☐ A Small entity statement is enclosed
- b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
- c. ☐ Is no longer claimed.

20. ☒ A check in the amount of \$ 760.00 to cover the filing fee is enclosed.

21. ☐ A check in the amount of \$ _____ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

- a. ☒ Fees required under 37 CFR 1.16.
- b. ☐ Fees required under 37 CFR 1.17.
- c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	LEONARD P. DIANA, ESQ.
SIGNATURE	
DATE	January 26, 1999

TWO-DIMENSIONAL IMAGE PICKUP APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to a two-dimensional image pickup apparatus and, more particularly, it relates to a two-dimensional image pickup apparatus adapted to X-ray photography.

Related Background Art

10 FIG. 1 of the accompanying drawings schematically illustrates a known image pickup apparatus adapted to X-ray photography and comprising a fluorescent member (e.g. scintillator) 1 for converting X-rays into rays of visible light, photoelectric
15 converters 2a for converting visible light into electric signals, a substrate 2b carrying the photoelectric converter 2a thereon, a base member 7 supporting the substrate 2b thereon, circuit boards 5a, 5b for processing electric signals produced by
20 photoelectric conversion, wires connected to the circuit boards and an apparatus cabinet 8 containing the above components.

 The substrate 2b arranged under the photoelectric converters 2a (hereinafter referred to
25 simply as substrate) is typically made of glass because it is required to be free from chemical reactions with the photoelectric converters of semiconductor, resist

the high temperature of the semiconductor forming process and maintain dimensional stability. The fluorescent member 1 is prepared by applying a fluorescent material of a metal compound to a resin plate. The gap separating the fluorescent member 1 and the photoelectric converters 2a has to be held to a sufficiently small value (typically less than tens of several micrometers) relative to the size of the pixels of the photoelectric converters 2a and, in most cases, the fluorescent member 1 and the substrate 2b are bonded together. Note that, in FIG. 1, photoelectric converter unit 102 refers to an assembly of a fluorescent member 1, a moisture-impermeable film 6 and other members arranged on the substrate 2b.

When the photoelectric converters 2a are required to be moisture-resistant, the fluorescent member 1 and the photoelectric converters 2a may be wrapped and hermetically sealed by a moisture-impermeable and X-ray transmissive film 6. Then, they are bonded and securely held to the base member 7 before contained in the apparatus cabinet 8 to complete the operation of assembling the image pickup apparatus for X-ray photography.

Such image pickup apparatuses are conventionally used for X-ray photography as stationary apparatus. However, in recent years, there is an increasing demand for lightweight, compact and portable

image pickup apparatus adapted to rapid imaging operations for producing fine images.

Additionally, image pickup apparatus having the above described configuration are required to safeguard the substrate 2b and other related components against impacts that can be applied thereto during transportation and the apparatus are also required to be safeguarded as a whole against deformations that can be caused by the external load (mainly the weight of the person to be photographed) of the apparatus during X-ray photographing operations. To meet these requirements, then the apparatus cabinet 8 has to be structurally very robust and this necessity of being robust has been obstructing the attempt to down-size and reduce the weight of the apparatus.

SUMMARY OF THE INVENTION

In view of the above described circumstances, it is therefore the object of the present invention to provide an image pickup apparatus for X-ray photography structurally adapted to absorb external impacts and possible resultant deformations such as deflections of the cabinet so that the interior is protected against damage and remains intact if the cabinet is deformed by the external load.

According to the invention, the above object of the invention is achieved by providing a

two-dimensional image pickup apparatus comprising an apparatus cabinet containing therein a substrate member and a photoelectric converter unit having a plurality of photoelectric converters formed on the substrate member, at least the photoelectric converter unit being arranged on a base member and the portion of the cabinet located opposite to its light receiving section is deformable.

Preferably, the portion of the cabinet located opposite to the light receiving section can restore the original position after deformation.

Preferably, the magnitude of deformation of the portion of the cabinet located opposite to the light receiving section is greater than that of the substrate member.

According to the invention, there is also provided an image pickup apparatus comprising a substrate, a photoelectric converter unit having a plurality of photoelectric converters and a cabinet containing the photoelectric converter unit, a shock absorbing means being arranged between the photoelectric converter unit and the cabinet.

For the purpose of the invention, the shock absorbing means may be containers.

For the purpose of the invention, the containers may contain gas in a sealed state.

A two-dimensional image pickup apparatus

according to the invention may further comprise a circuit board for processing electric signals from the photoelectric converters also contained in the apparatus cabinet and cooling liquid is contained in a sealed state at least in the containers held in direct contact with the electronic parts arranged on the circuit board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross sectional view of a typical two-dimensional image pickup apparatus.

FIGS. 2, 3A, 4 and 5 are schematic cross sectional views of embodiments of two-dimensional image pickup apparatus according to the invention.

FIG. 3B is a schematic perspective view of the embodiment of two-dimensional image pickup apparatus of FIG. 3A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the present invention will be described in greater detail by referring to the accompanying drawings that illustrate preferred embodiments of the invention. However, the present invention is by no means limited to the embodiments as illustrated and described below, which may be modified appropriately in different ways without departing from the scope of the invention.

(First Embodiment)

FIG. 2 is a schematic cross sectional view of a first embodiment of the invention. In FIG. 2, the components same as or similar to those of the apparatus of FIG. 1 are denoted respectively by the same reference symbols.

In this embodiment, at least the top plate 81 constituting the cabinet is made of an easily deformable material. As a result, the top plate 81 deforms only within the space between the top plate 81 and the photoelectric converter unit 102 if a small impact is applied to it so that the impact will not be transmitted to the photoelectric converter unit 102 or, if transmitted, the effect of the impact can be significantly reduced.

Additionally, the base member 7 rigidly carrying the photoelectric converter unit 102 thereon shows a rigidity (resistance against deformation by force) greater than that of the top plate 81 so that, if a load 201 is applied to the top plate 81, the magnitude of deformation of the base member 7 due to the load is smaller than that of top plate 81 and hence the impact of the load is borne by the base member 7 to protect the photoelectric converter unit 102 against deformation and damage.

The top plate 81 is preferably made of a material that is highly impact-resistant and resilient

so that it may restore the original profile once the load or some other external force that has been applied to it is removed. Specific examples of materials that can be used for the top plate 81 include carbon- or

5 Kevlar-reinforced resin, polyamide resin and polyimide resin. Above all, the use of carbon-fiber-reinforced resin is highly preferable in view of the X-ray transmittivity of the material.

(Second Embodiment)

10 FIGS. 3A and 3B schematically illustrate a second embodiment of the invention, which will be specifically described below. There are shown a fluorescent member 1, two-dimensionally arranged photoelectric converters 2a, a substrate 2b typically

15 made of glass and a moisture-impermeable film 6, of which the moisture-impermeable film 6, the fluorescent member 1 and the substrate 2b are bonded together.

Reference symbol 5a denotes a flexible circuit board for taking out signals from the photoelectric

20 converters and reference symbol 5b denotes a circuit board for processing signals, which circuit boards are folded and arranged on the rear surface of the substrate 2b for the purpose of down-sizing. The above

25 components are typically made of a glass plate or a semiconductor material and hence they are fragile and poorly resistant against impact.

The space between the components and the

apparatus cabinet 8 is filled with containers 9 containing air or other gases in the inside in a hermetically sealed state as shock absorbing means. The containers 9 are made of an X-ray transmissive elastic material to define the positions of the photoelectric converters 2a relative to the apparatus cabinet 8 and absorb any load-induced impact through the compressive deformation of the internal gas in order to protect the substrate 2b and other fragile components against impact during transportation.

During an X-ray photographing operation, the image pickup apparatus 8 is subjected to the load of the object to be photographed and can become deflected or otherwise deformed. However, the containers 9 distribute the load and prevent the load from being intensively borne by part of the substrate 2b to get damaged.

Since the apparatus cabinet 8 itself is required to be transmissive of X-rays and lightweight as pointed out above, it is typically formed by combining a metal plate and CFRP (carbon-fiber-reinforced plastic) but the load bearing capacity of the apparatus cabinet 8 (that may be improved by increasing the thickness of the cabinet to baffle the effort of reducing its weight) does not particularly have to be taken into consideration because the containers 9 operate as reinforcement for

protecting the inner components as they are elastically deformed.

(Third Embodiment)

FIG. 4 schematically illustrates a third
5 embodiment of the invention also comprising containers
9, of which at least those held in direct contact with
the electronic parts 5c arranged on the circuit board
5b are made to contain cooling liquid 9a therein in a
hermetically sealed state in order to cool them because
10 many of the electronic parts 5c consume power and
generate heat. As a result, the electronic parts are
encouraged to emit heat so that malfunctions of the
circuit due to heat can be avoided and the cabinet can
be down-sized in an effective way.

15 The containers 9 containing cooling liquid in a
sealed state are preferably held in contact with the
electronic parts 5c and, at the same time, with the
apparatus cabinet 8. Those portions of the apparatus
cabinet 8 that are held in contact with the related
20 containers 9 is advantageously made of a thermally
highly conductive material such as metal.

Additionally, the apparatus cabinet 8 may be provided
with heat-emitting fins (not shown), whose dimensions
are, of course, confined within a permissible limit.

25 (Fourth Embodiment)

While the profile and the size of the
containers 9 operating as shock absorbing means are not

particularly limited, FIG. 5 shows a single container 9 arranged at the side for receiving X-rays 101 to entirely or mostly cover the light receiving surface of the photoelectric converter unit 102.

5 With such an arrangement, the possible absorption, if any, of X-rays by the light receiving side container 9 along the direction of transmission can be minimized to improve the resolution of the transmitted X-rays.

10 The containers 9 may contain a gelled or deformable solid material in place of gas or liquid, although the transmittivity of electromagnetic waves having a desired wavelength has to be carefully taken into consideration at the light receiving side of the
15 photoelectric converter unit.

 As described above in detail, an image pickup apparatus adapted to X-ray photography according to the invention shows an improved shock-absorbing property and an enhanced load bearability to allow the apparatus
20 to be further down-sized and become lightweight.

 As a result, it is now possible to realize a portable two-dimensional image pickup apparatus.

 As described above, the present invention provides a two-dimensional image pickup apparatus
25 comprising a substrate, photoelectric converters formed on the substrate and an apparatus cabinet containing said substrate and said photoelectric converters, a

plurality of shock-absorbing members such as air bags
being inserted into the gap between said substrate and
said apparatus cabinet to prevent the inner wall
surface of said apparatus cabinet and said substrate
5 from contacting each other. With such an arrangement,
if the cabinet and the top plate are deformed, damages
to the inner components can be minimized and the
apparatus can be down-sized and made lightweight to
make it conveniently portable. When the containers or
10 the air bags are made to contain cooling liquid, the
circuit is encouraged to emit heat in an efficient way.

WHAT IS CLAIMED IS:

1. A two-dimensional image pickup apparatus comprising an apparatus cabinet containing therein a substrate member and a photoelectric converter unit
5 having a plurality of photoelectric converters formed on the substrate member, at least the photoelectric converter unit being arranged on a base member and the portion of the cabinet located opposite to its light receiving section is deformable.

10

2. A two-dimensional image pickup apparatus according to claim 1, wherein the portion of the cabinet located opposite to the light receiving section can restore the original position after deformation.

15

3. A two-dimensional image pickup apparatus according to claim 1, wherein the magnitude of deformation of the portion of the cabinet located opposite to the light receiving section is greater than
20 that of the substrate member.

4. A two-dimensional image pickup apparatus according to claim 1, wherein a shock absorbing means is arranged between the photoelectric converter unit
25 and the cabinet.

5. A two-dimensional image pickup apparatus

according to claim 4, wherein the shock absorbing means comprises containers.

6. A two-dimensional image pickup apparatus
5 according to claim 5, wherein the containers are air bags.

7. A two-dimensional image pickup apparatus
according to claim 1, further comprising a circuit
10 board for processing electric signals from the photoelectric converters also contained in the image pickup apparatus, cooling liquid being contained in a sealed state at least in the containers held in direct contact with the electronic parts arranged on the
15 electric circuit substrate.

8. A two-dimensional image pickup apparatus
according to claim 1, wherein the portion of the cabinet located opposite to the light receiving section
20 is made of resin.

9. A two-dimensional image pickup apparatus
according to claim 1, wherein the resin contains carbon-fiber-reinforced resin.

25

10. A two-dimensional image pickup apparatus
according to claim 1, wherein the photoelectric

converter unit include a fluorescent body.

11. A two-dimensional image pickup apparatus
comprising a substrate, a photoelectric converter unit
5 having a plurality of photoelectric converters formed
on the substrate and a cabinet containing the
photoelectric converter unit, a shock absorbing means
being arranged between the photoelectric converter unit
and the cabinet.

10

12. A two-dimensional image pickup apparatus
according to claim 11, wherein the shock absorbing
means comprises containers.

15

13. A two-dimensional image pickup apparatus
according to claim 12, wherein the containers contain
gas in a sealed state.

20

14. A two-dimensional image pickup apparatus
according to claim 12, wherein the containers are air
bags.

25

15. A two-dimensional image pickup apparatus
according to claim 11, further comprising a circuit
board contained in the cabinet for processing electric
signals relating to the photoelectric converters and a
cooling means held in contact with the electronic parts

of the circuit substrate.

16. A two-dimensional image pickup apparatus
according to claim 15, wherein the cooling means
5 comprises containers containing cooling liquid therein.

ABSTRACT OF THE DISCLOSURE

An image pickup apparatus for X-ray photography is structurally adapted to absorb external impacts and possible resultant deformations such as deflections of the cabinet so that the interior is protected against damage and remains intact if the cabinet is deformed by the external load. The two-dimensional image pickup apparatus comprises a substrate, two-dimensional photoelectric converters formed on the substrate and an apparatus cabinet containing the substrate and the photoelectric converters in the inside, at least part of the apparatus cabinet being deformable and capable of restore the original profile or a plurality of containers such as air bags being inserted into the gap between said substrate and said apparatus cabinet to prevent the inner wall surface of said apparatus cabinet and said substrate from contacting each other.

FIG. 1

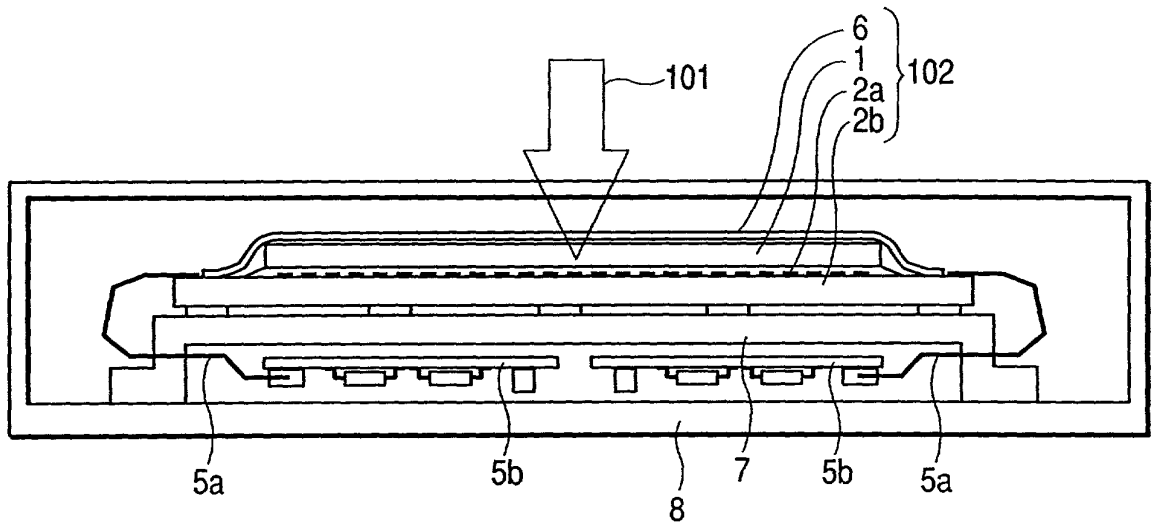


FIG. 2

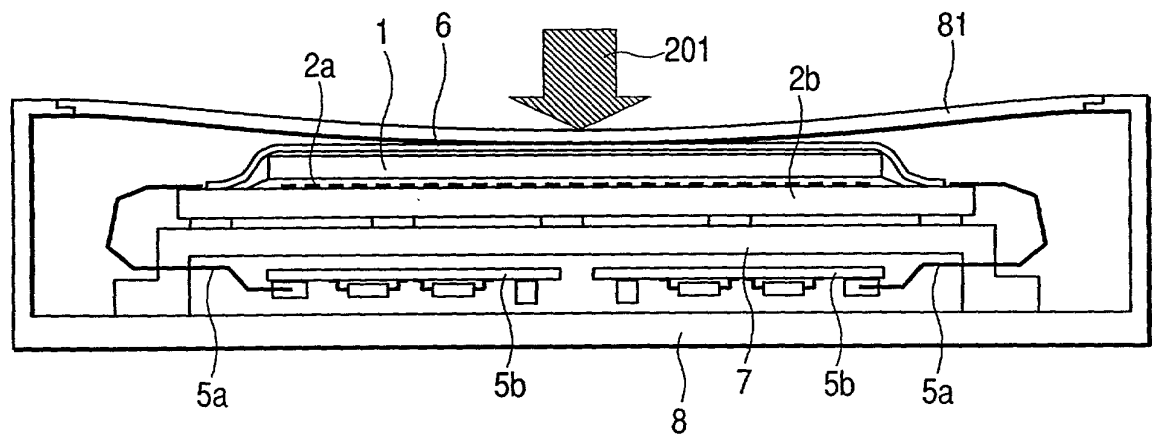


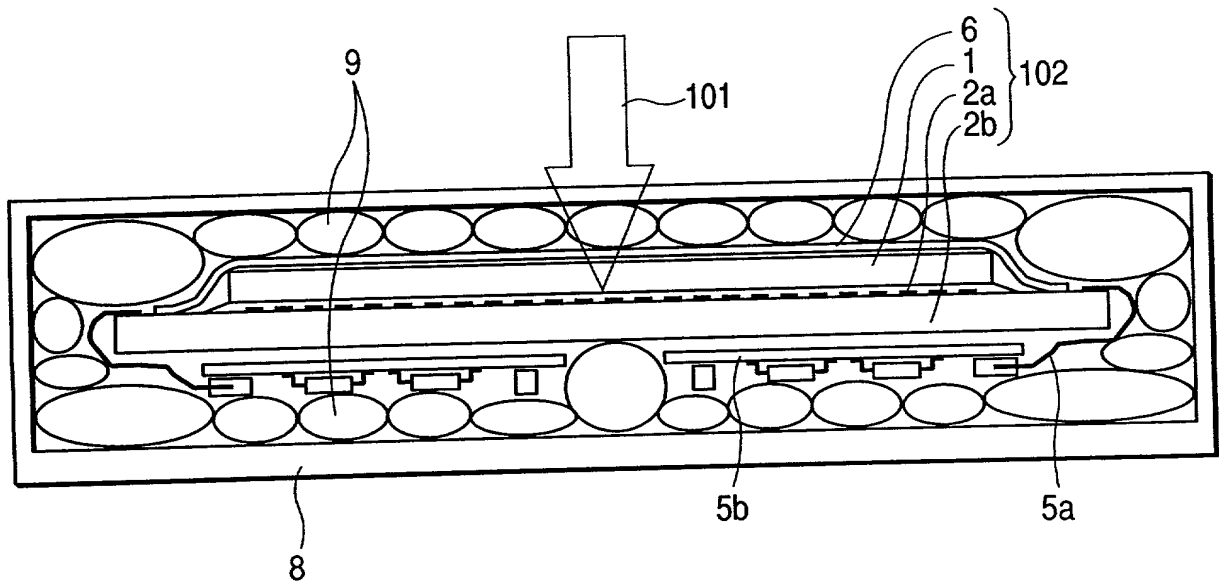
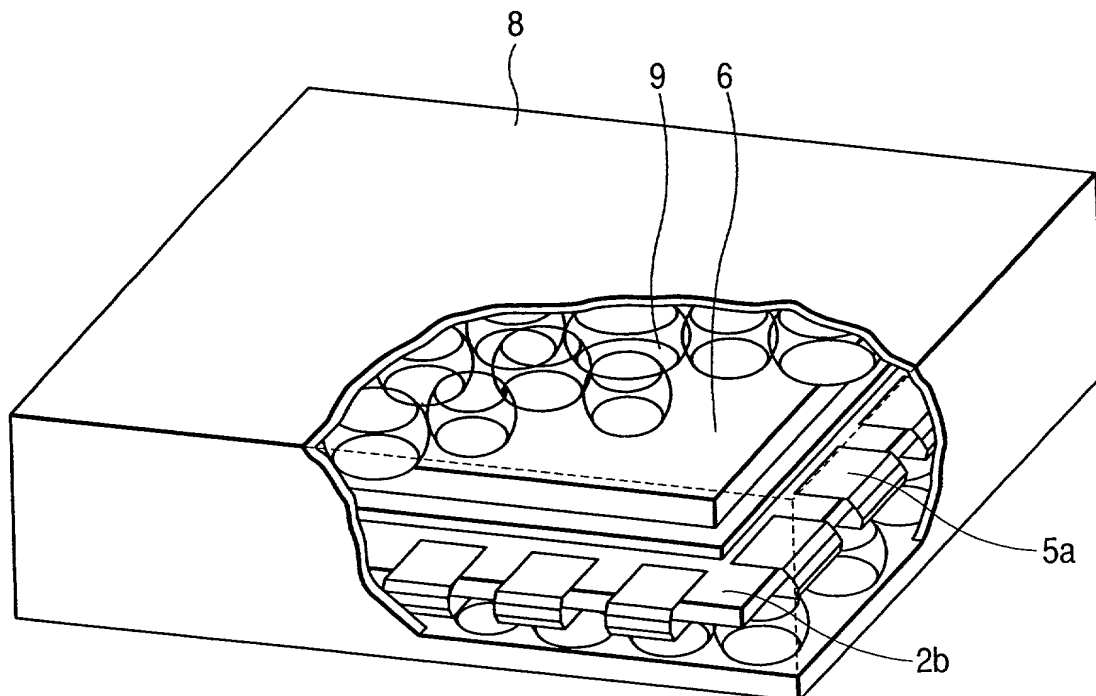
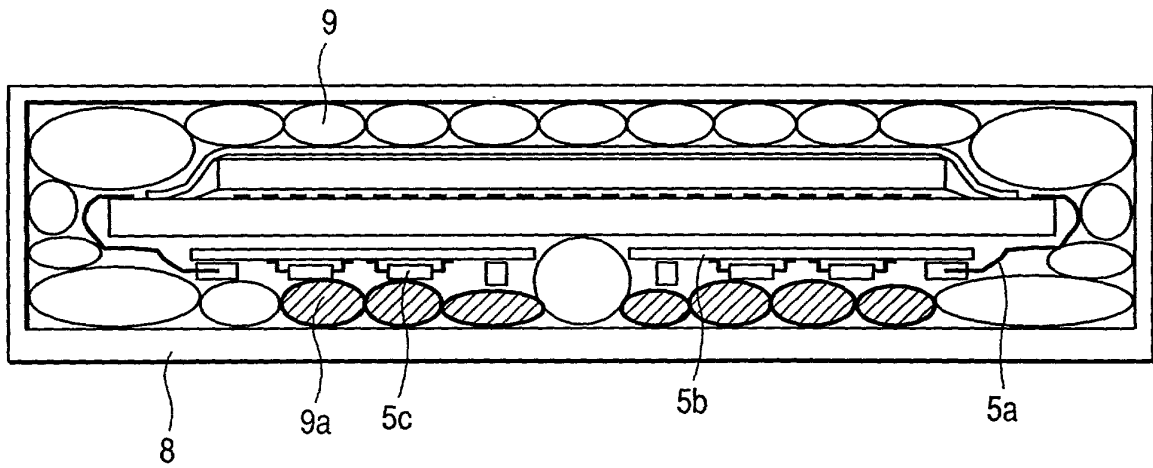
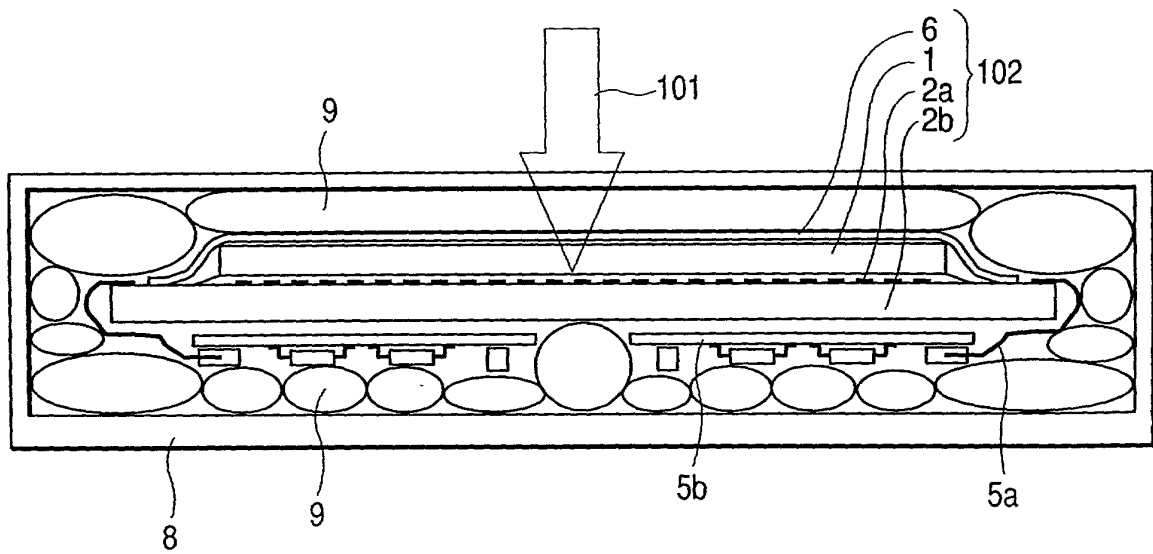
FIG. 3A**FIG. 3B**

FIG. 4**FIG. 5**

**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
(Page 1)**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled TWO-
DIMENSIONAL IMAGE PICKUP APPARATUS, the specification of which ☒ is attached hereto ☐ was
filed on _____ as United States Application No. or PCT International Application No. _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended
by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's
certificate, or § 365(a) of any PCT international application which designates at least one country other than the United States, listed below
and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing
date before that of the application on which priority is claimed:

<u>Country</u>	<u>Application No.</u>	<u>Filed (Day/Mo./Yr.)</u>	<u>(Yes/No) Priority Claimed</u>
Japan	10-015611	January 28, 1998	Yes
Japan	11-008807	January 18, 1999	Yes

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT international
application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not
disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I
acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available
between the filing date of the prior application and the national or PCT international filing date of this application.

<u>Application No.</u>	<u>Filed (Day/Mo./Yr.)</u>	<u>Status (Patented, Pending, Abandoned)</u>
------------------------	----------------------------	--

I hereby appoint the practitioners associated with the firm and Customer Number provided below to prosecute this application
and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to
the address associated with that Customer Number:

FITZPATRICK, CELLA, HARPER & SCINTO
Customer Number: 05514

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and
belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like
so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such
willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor FUMIO HATA
Inventor's signature _____
Date _____ Citizen/Subject of JAPAN
Residence 27-22, Inokashira 1-chome, Mitaka-shi, Tokyo, Japan